

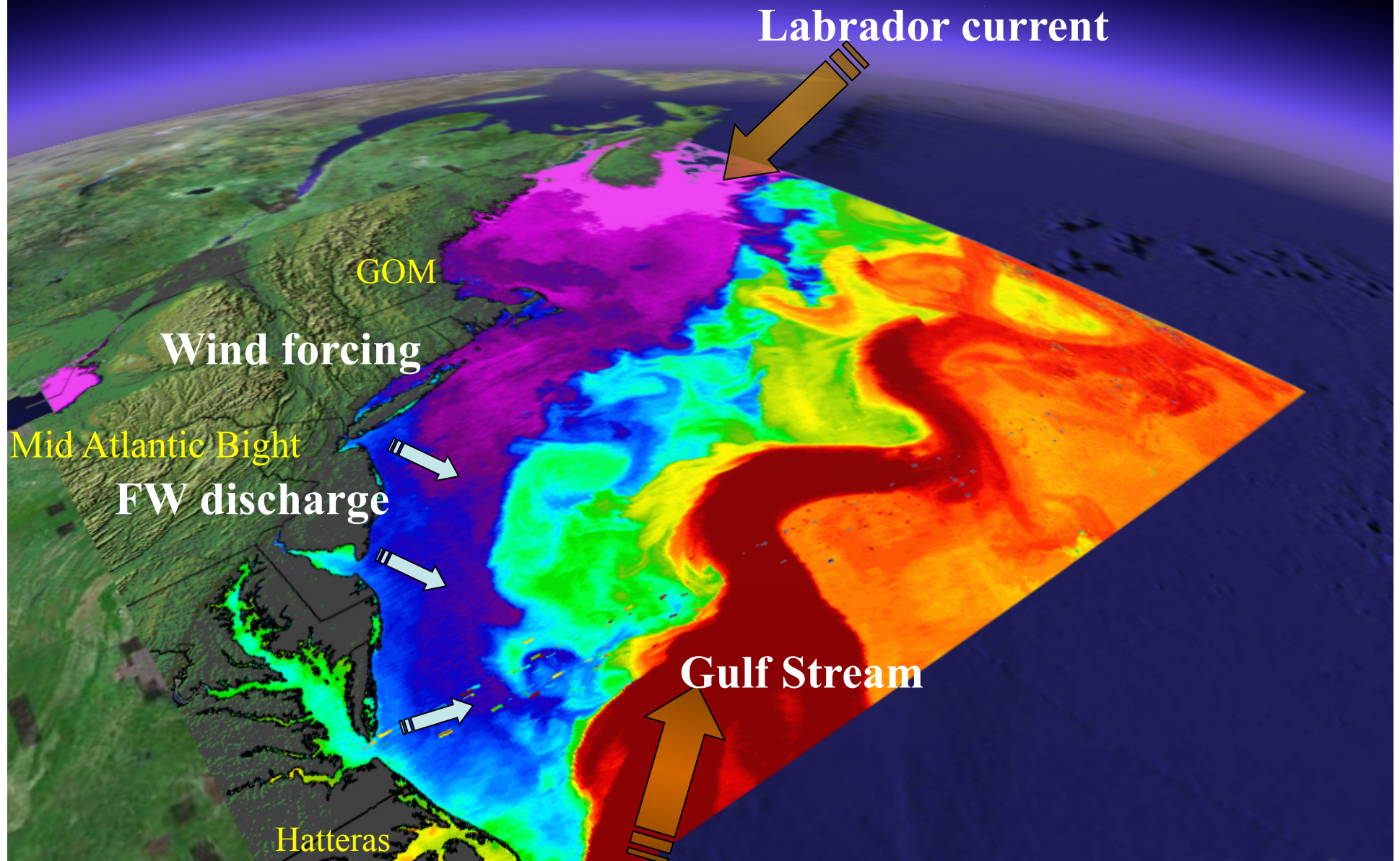
Climate change & seascape dynamics in the Mid-Atlantic Bight

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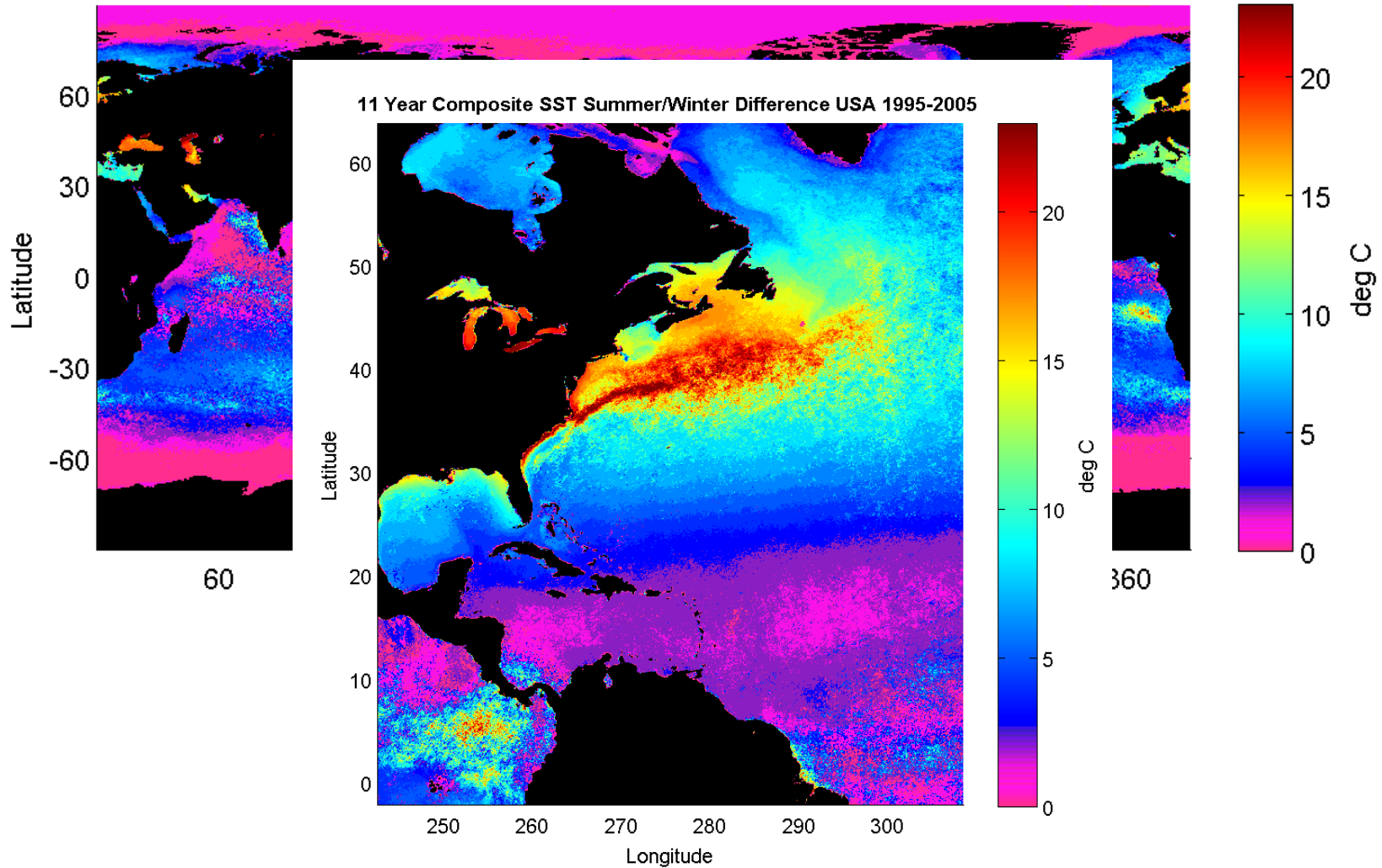
Mid Atlantic Bight Coastal Ocean
Habitat variation forced by weather & climate
(temperature, circulation, primary production)



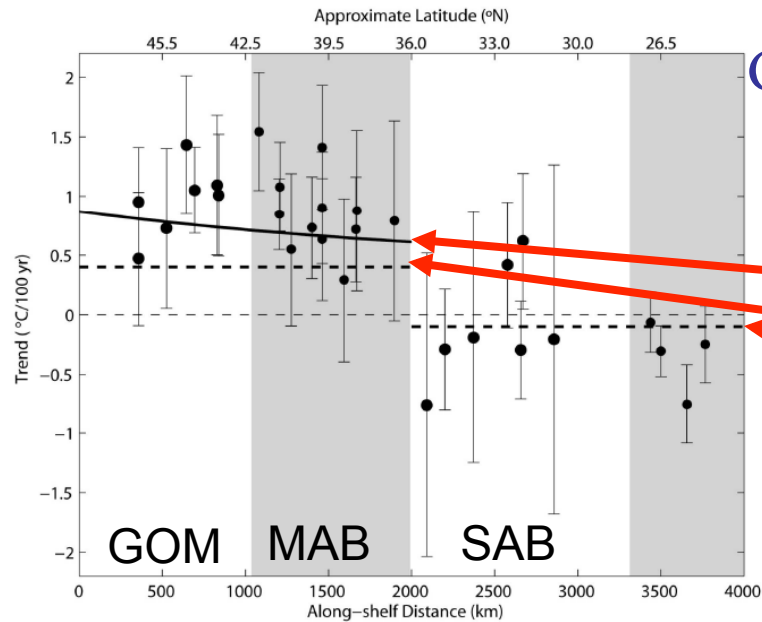
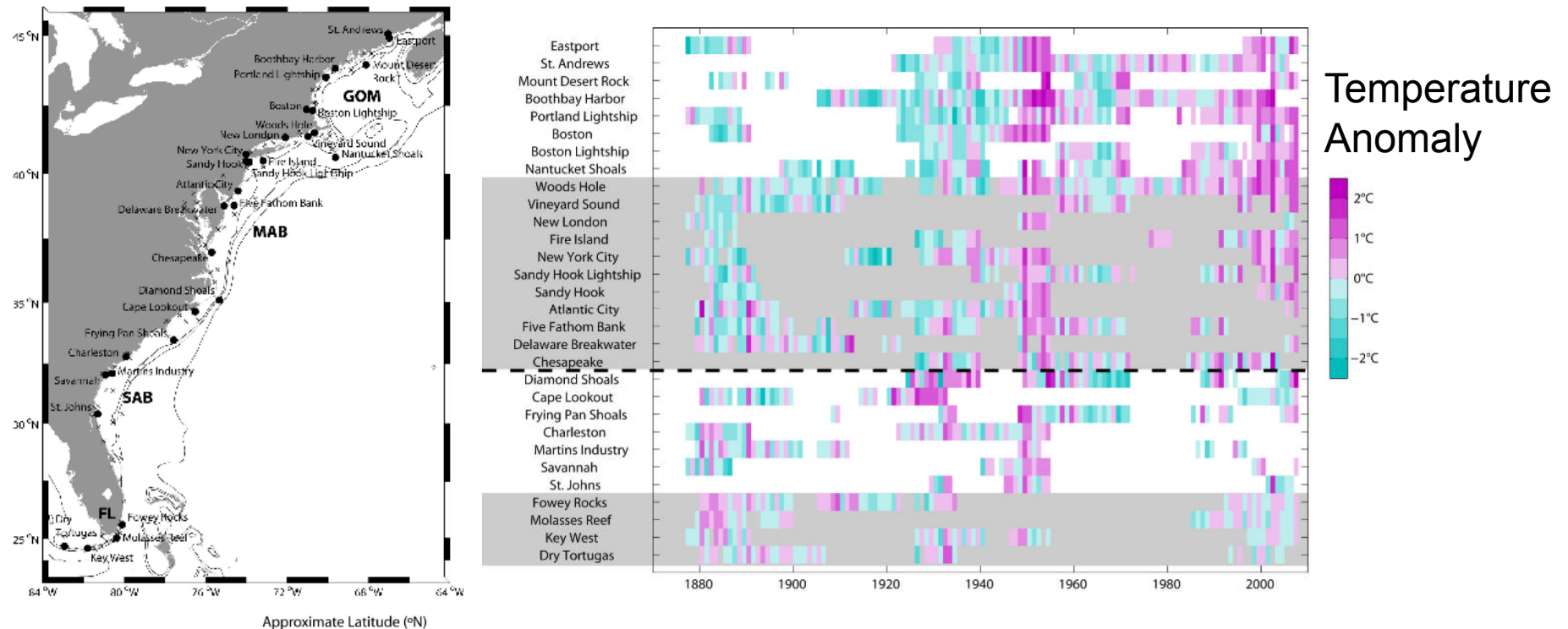
Seasonal Variability

Time a critical habitat dimension in MAB

11 Year Composite SST Summer/Winter Difference 1995-2005



Surface temperature trends: buckets on lightships & buoys



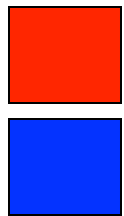
Greater change winter & spring (Jan, Feb, Mar)
than summer (Jul, Aug, Sep)

Advection from NE + Heat Flux

Local atmospheric heat flux

Sherman & Lentz (in press) JPO

Comparison of 1980s & 2000s Changes in seasonal patterns of 1° productivity



Positive anomaly

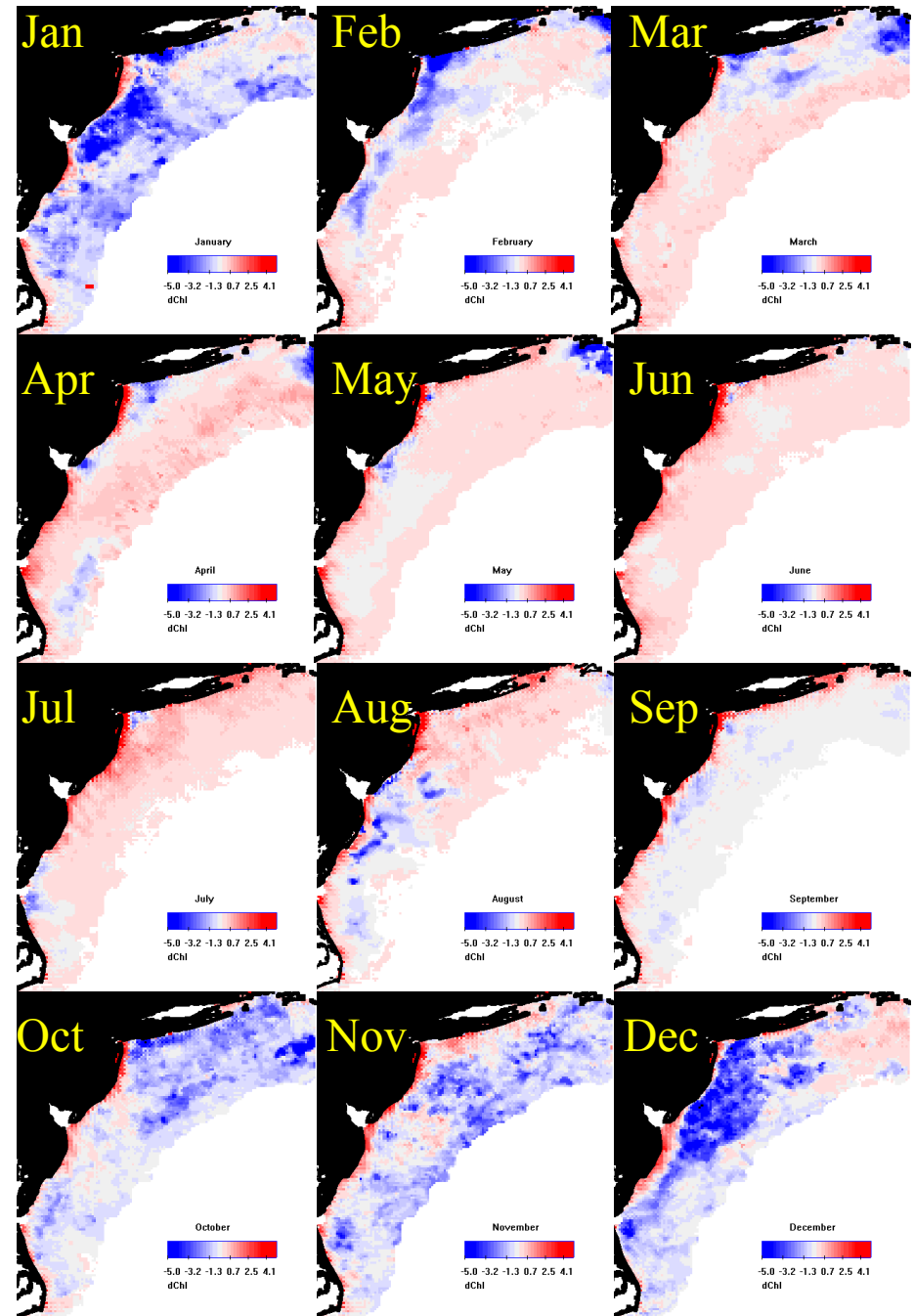
Negative anomaly

Earlier spring bloom

Higher summer productivity

Decrease productivity fall offshore bloom

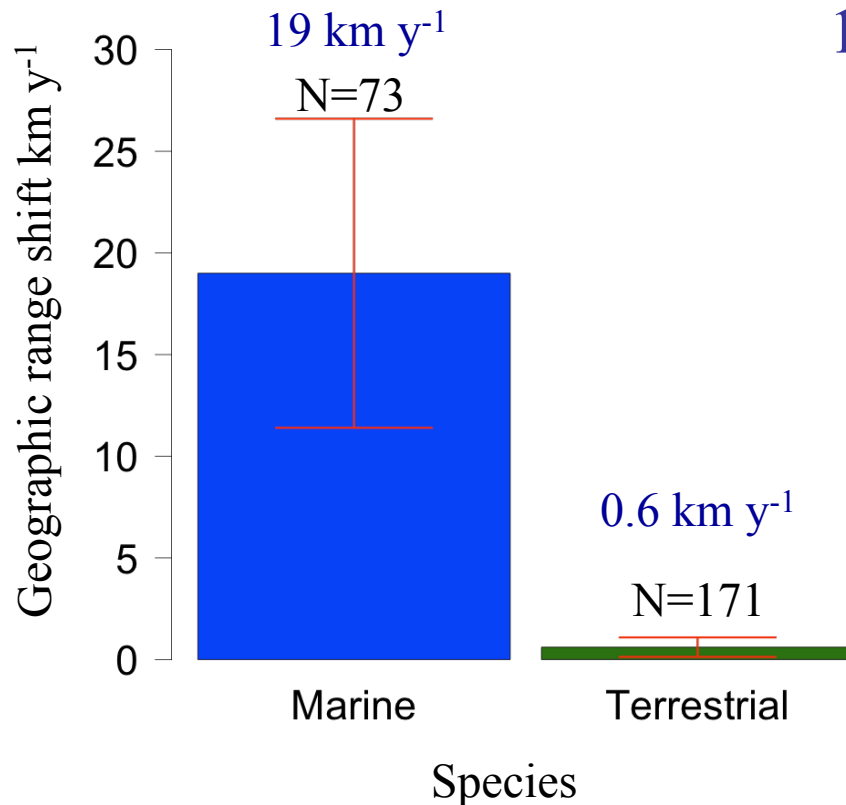
Changes in WC stratification & stability





Marine range shifts and species introductions: comparative spread rates and community impacts

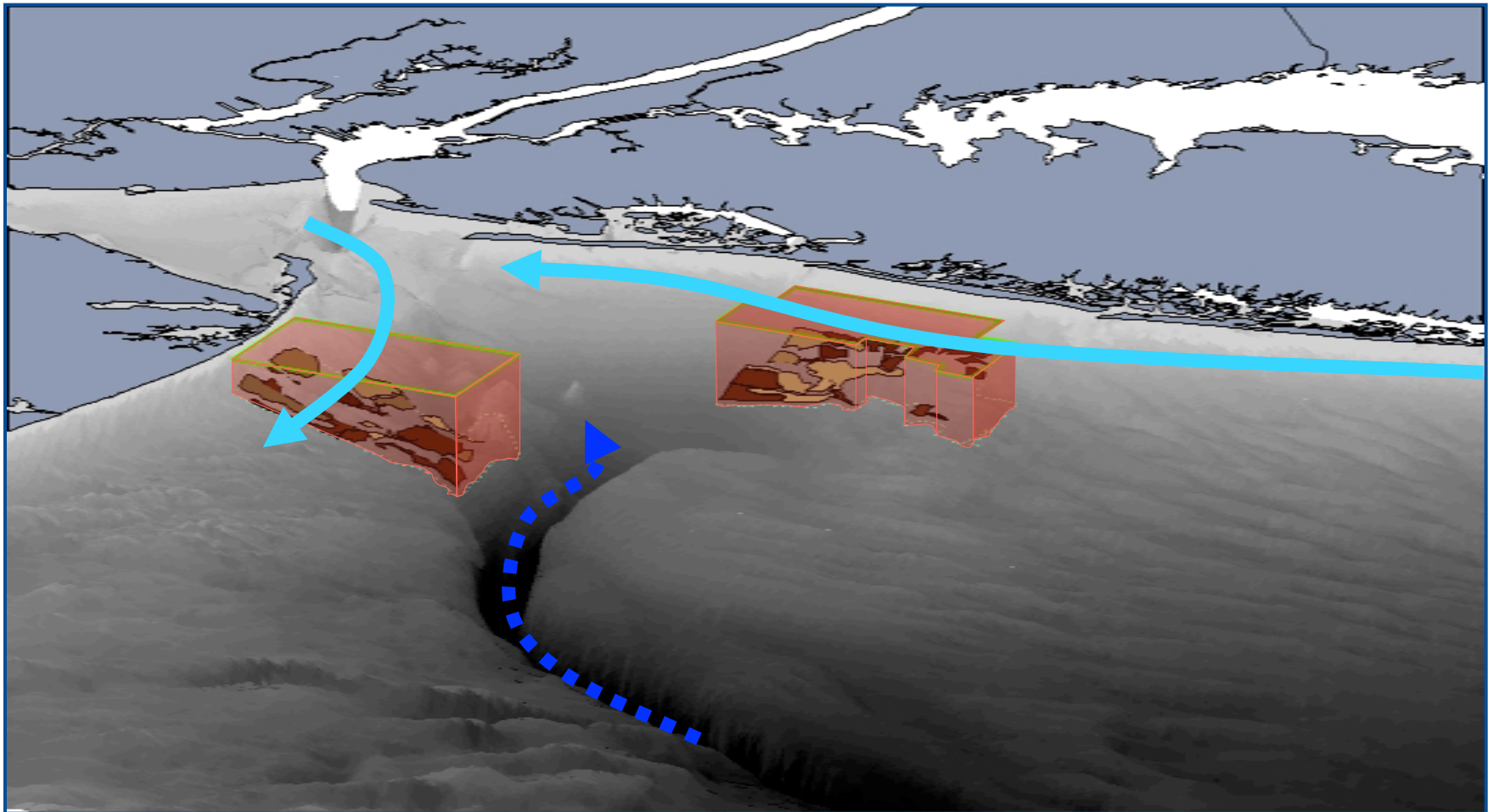
Cascade J. B. Sorte^{1*}, Susan L. Williams¹ and James T. Carlton²



129 marine species show range shifts
75% shifts poleward

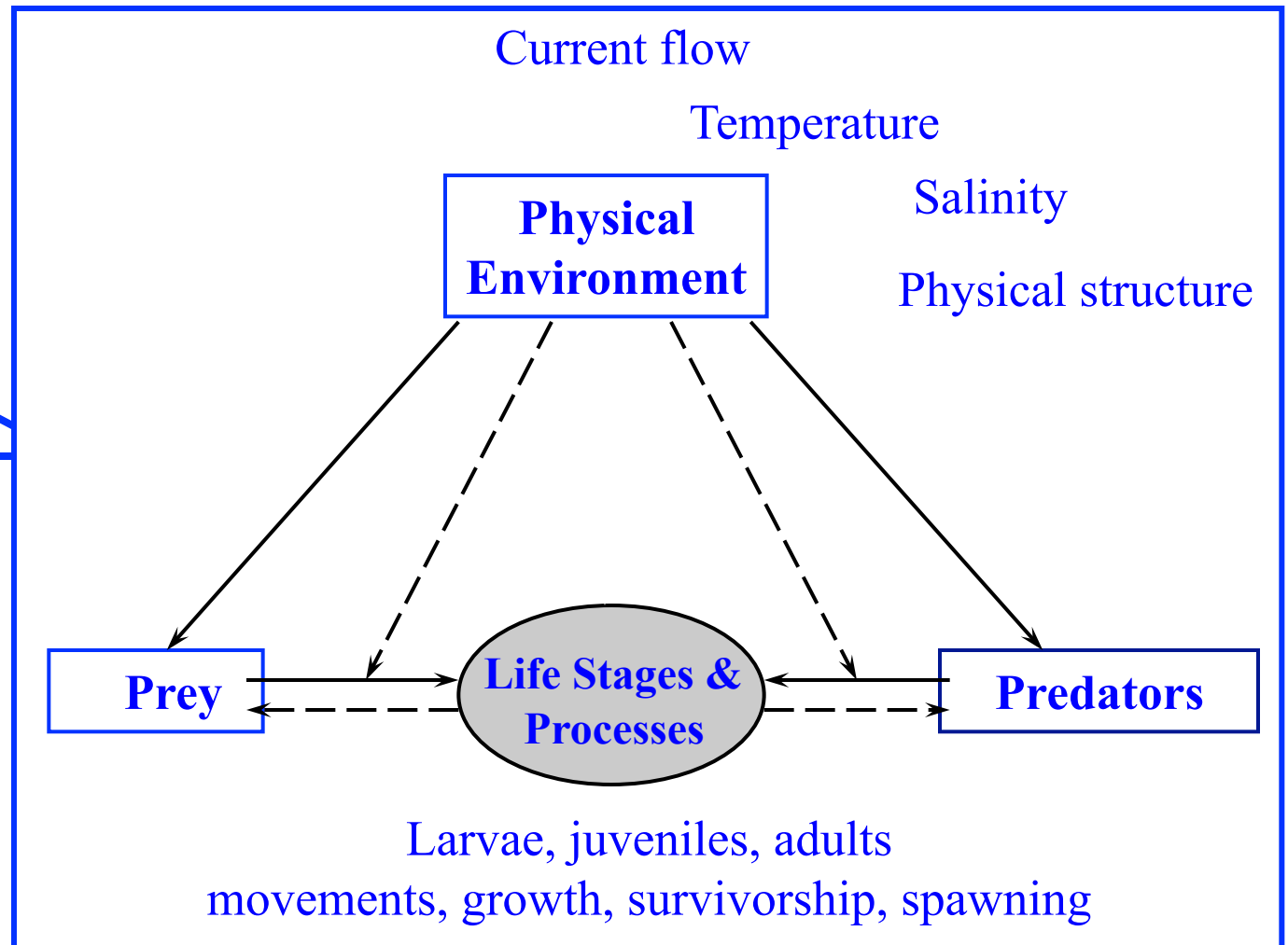
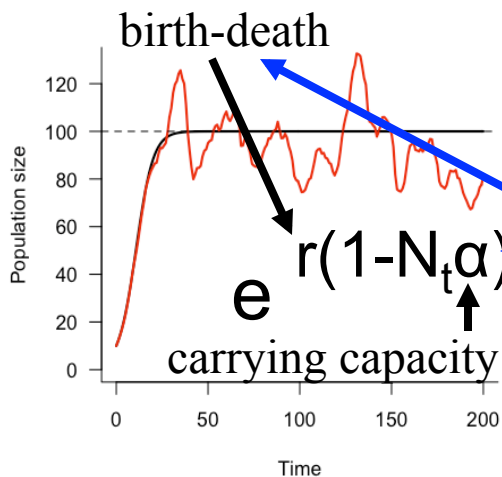
Why are range shifts an order of magnitude greater in the sea?

Seascapes: High productivity, high capacity & high concentration of organisms to meet Oligocene requirements, connected by animal movements & physical transport processes behaviors tightly coupled to characteristics of the fluid (e.g. temp, salinity, DO, circulation)



Marine population dynamics & “seascape” dynamics

Atmospheric forcing



Individuals requirements

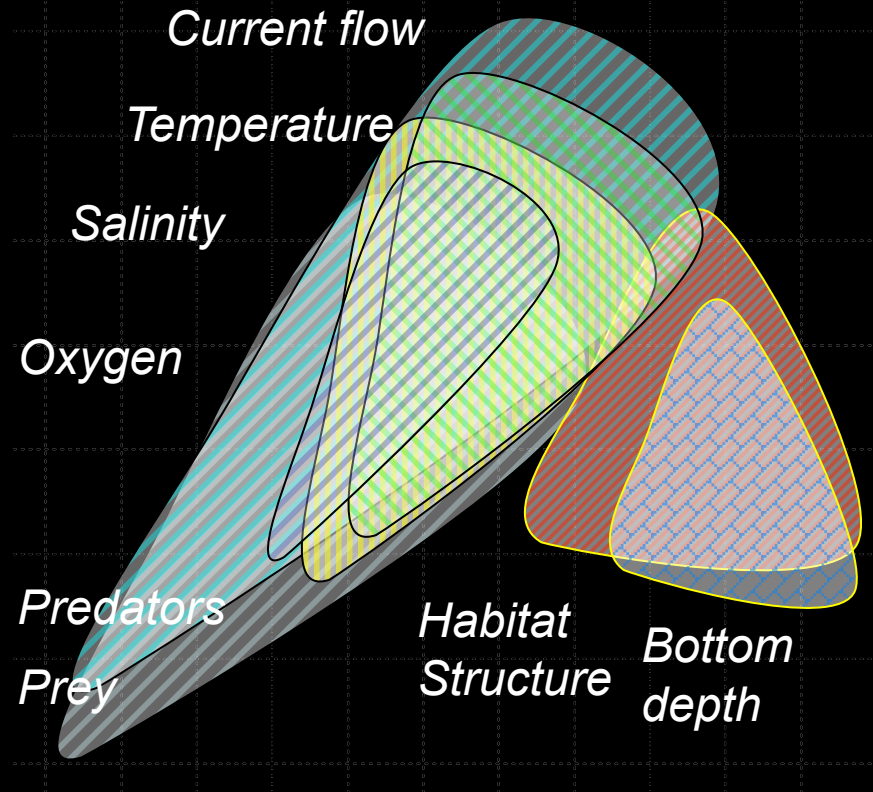


Regulate
Metabolism

Find prey
Find refuge:
rest & predation

Spatial scale
Coarse
Fine

Environment



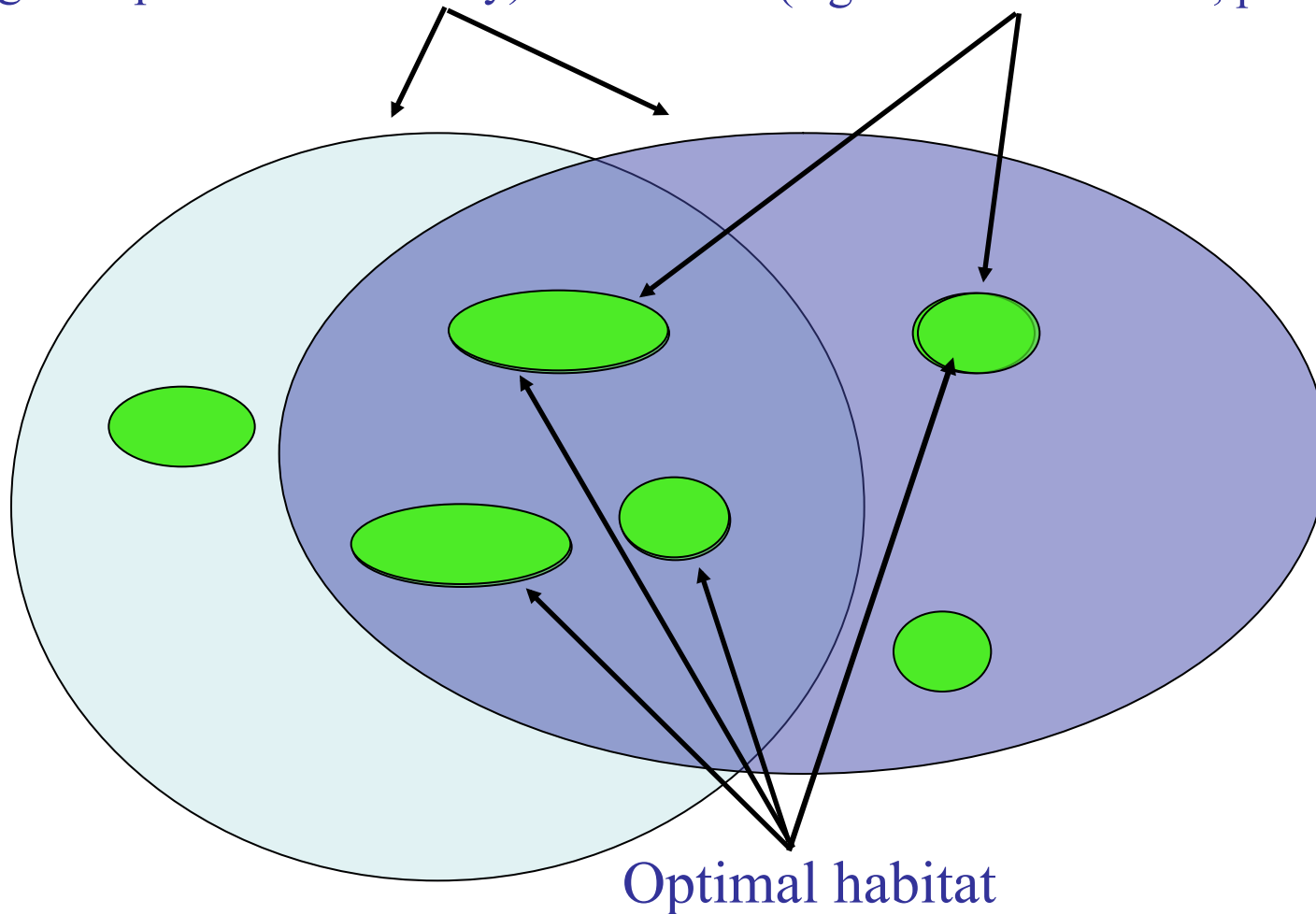
Fast Temporal dynamic *Slow*

Weather/climate driven factors have fast-coarse “habitat” dynamics
Control timing of optimal habitat formation & duration
Can have “fragmentation” in time as well as space

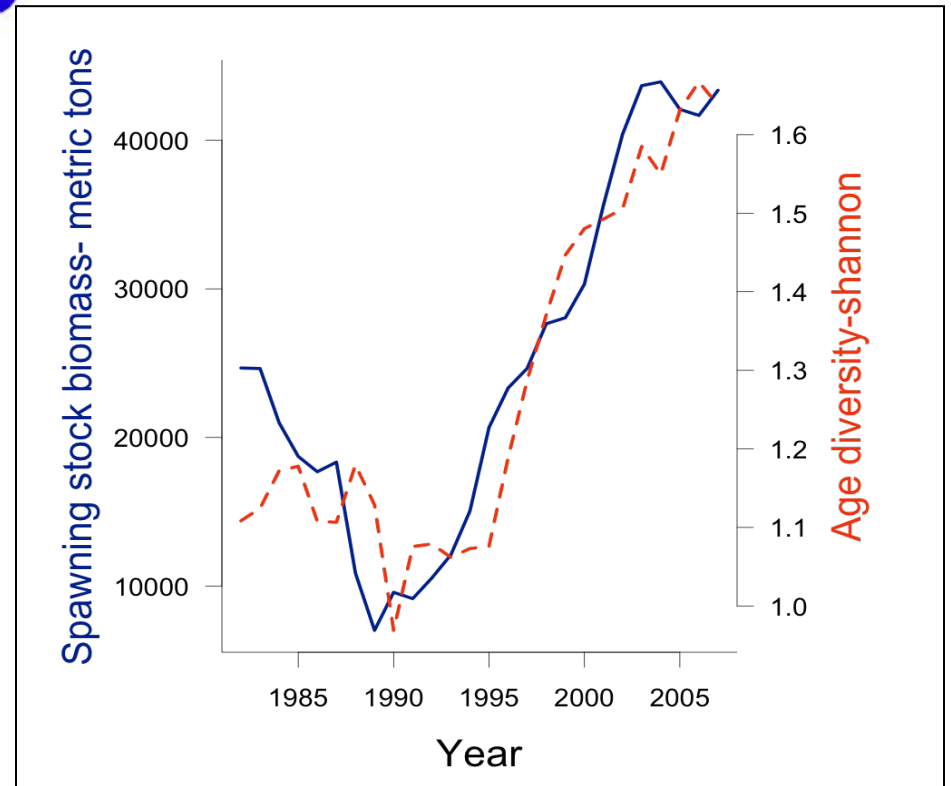
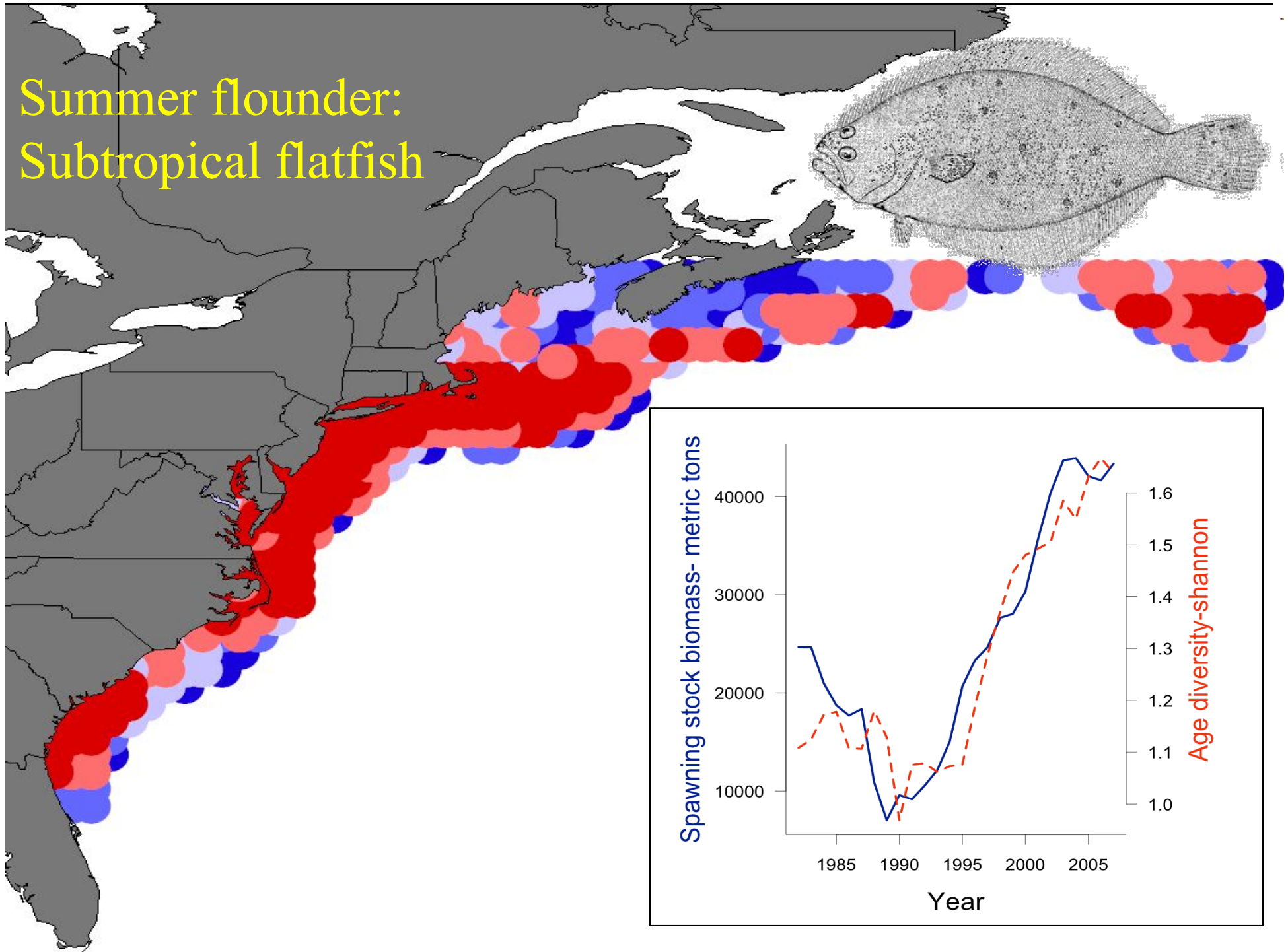
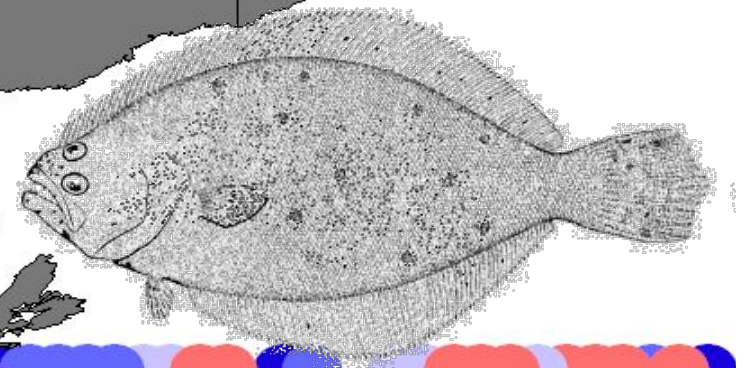
Optimal habitats: multiple environmental variables nested in space & time
Time dimension: suitable habitats ephemeral with timings & durations

Coarse-fast factors: Climate driven
(e.g. Temperature & salinity)

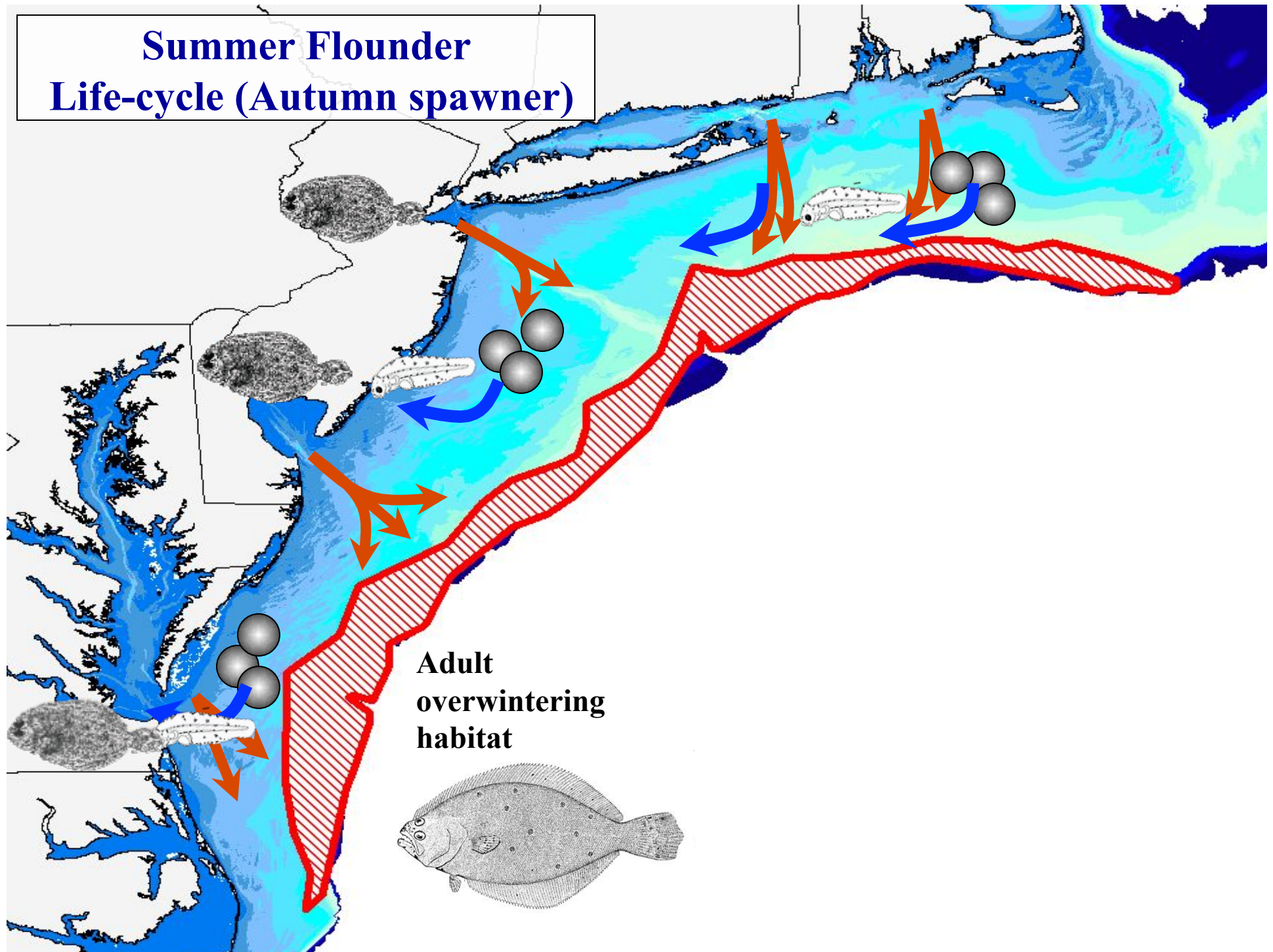
Fine-slow (or fast) factors
(e.g. Habitat structure, predators, prey)



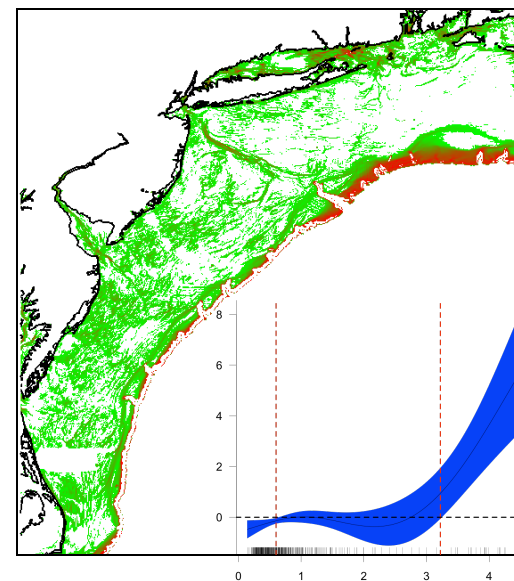
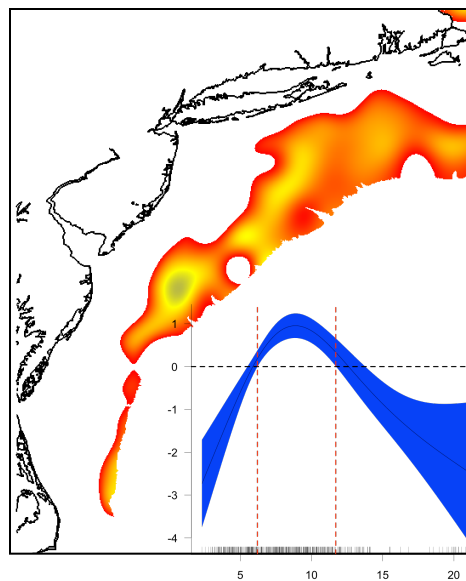
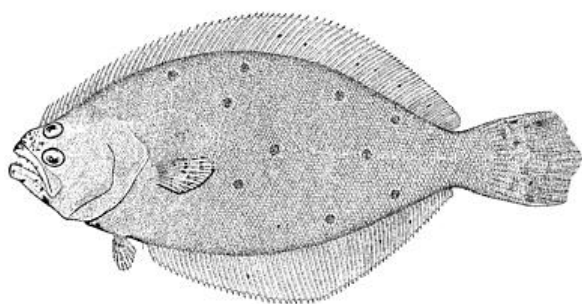
Summer flounder: Subtropical flatfish



Summer Flounder Life-cycle (Autumn spawner)

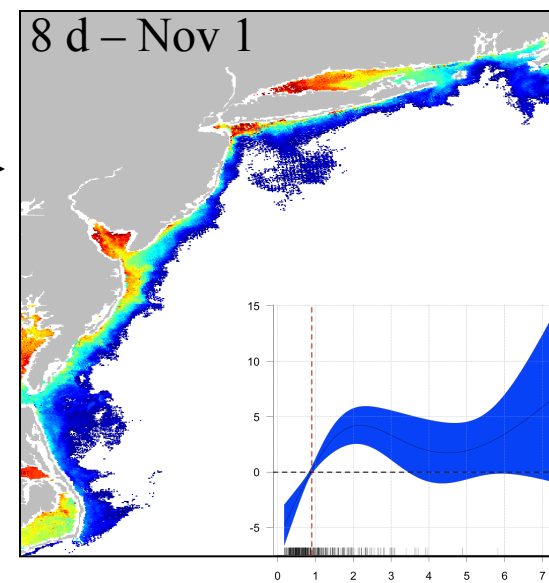
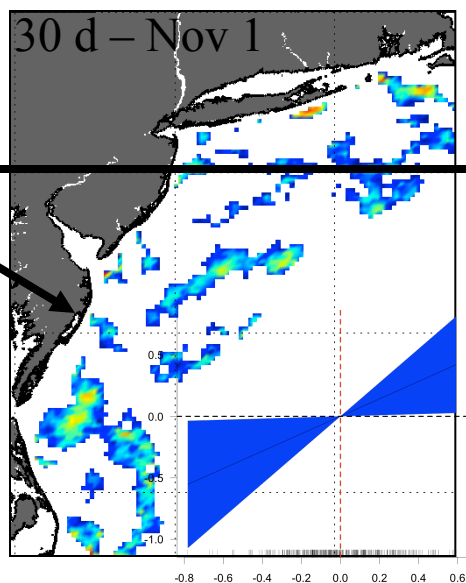


Adult habitat model Autumn offshore migration & spawning



= bottom temperature + bottom rugosity
+ current divergence + Chlorophyll-a*

Effects on growth, survival &
transport of eggs and larvae?



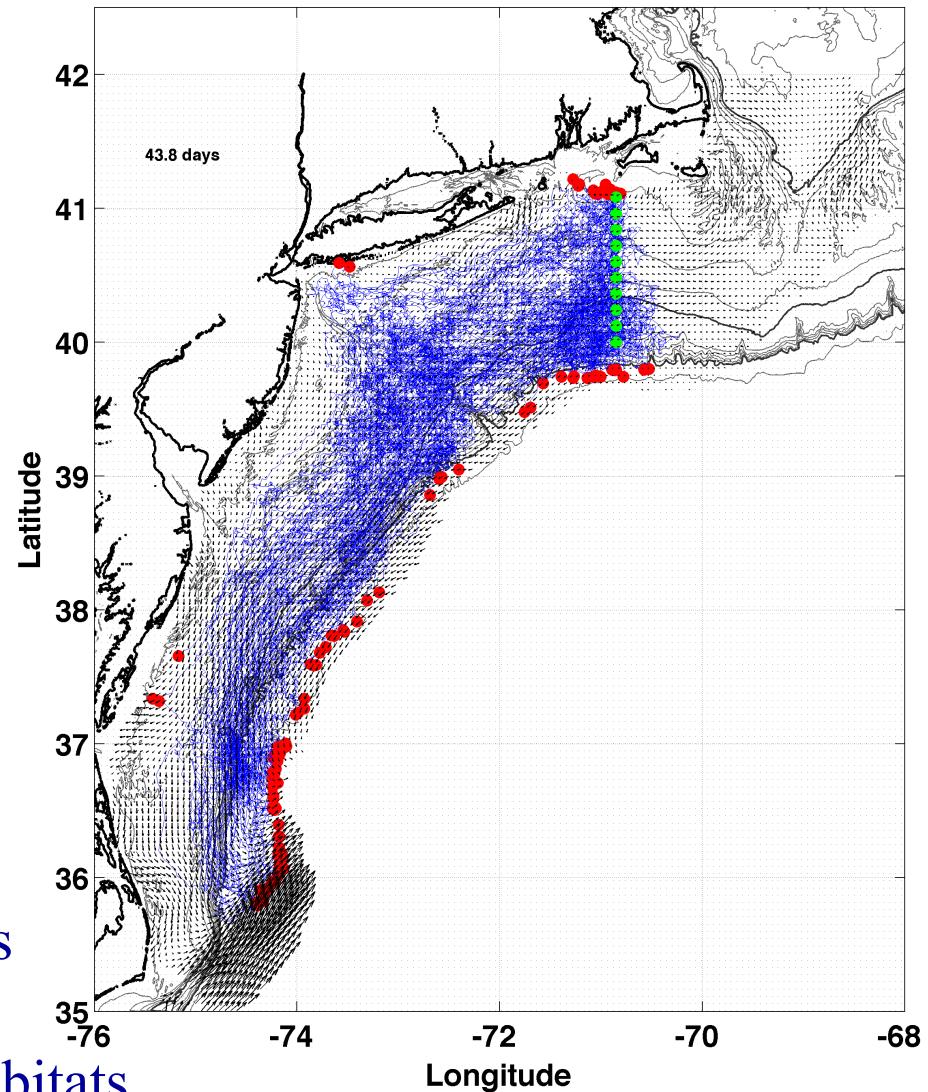
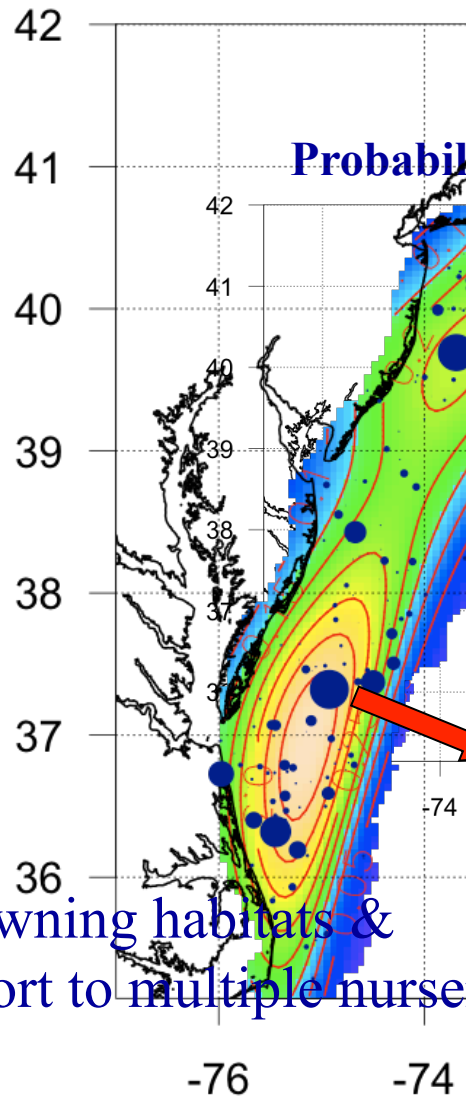
*Autumn

Divergence, 1° productivity, transport
driven by weather & climate

Particle trajectories in surface currents (HF radar) Probability of Egg Occurrence

Winter

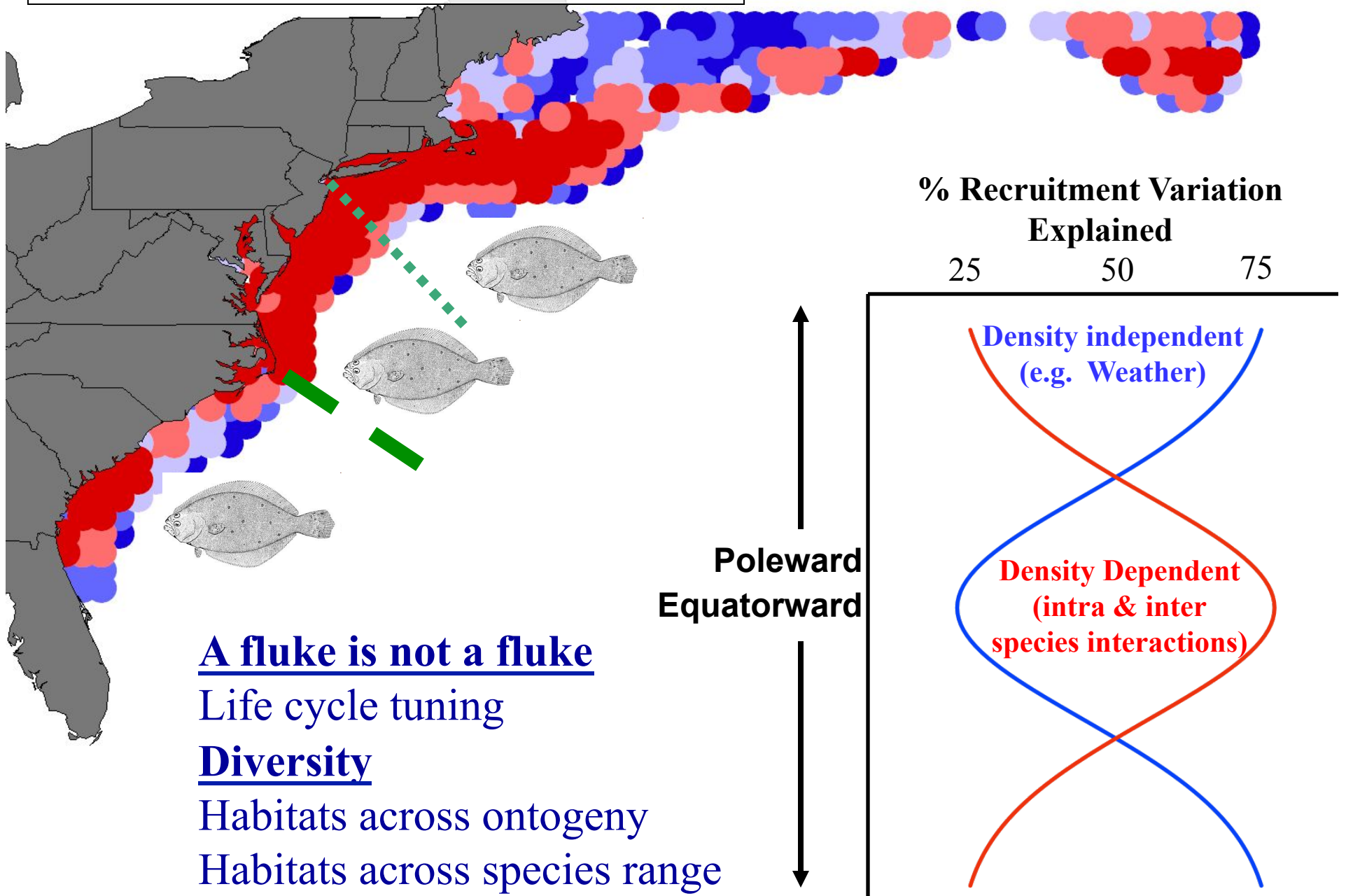
Spring



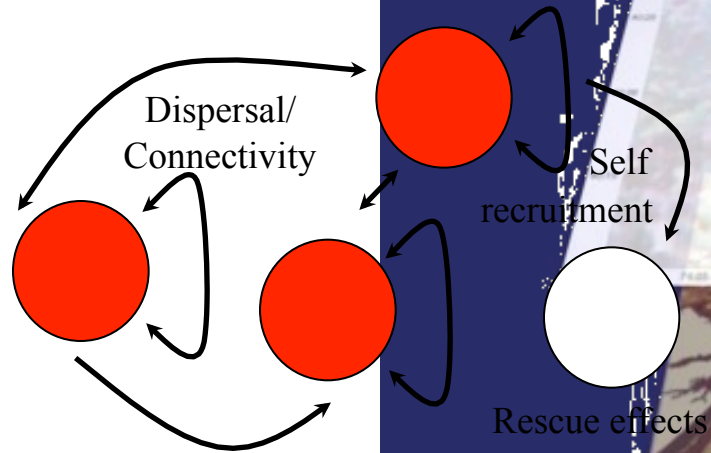
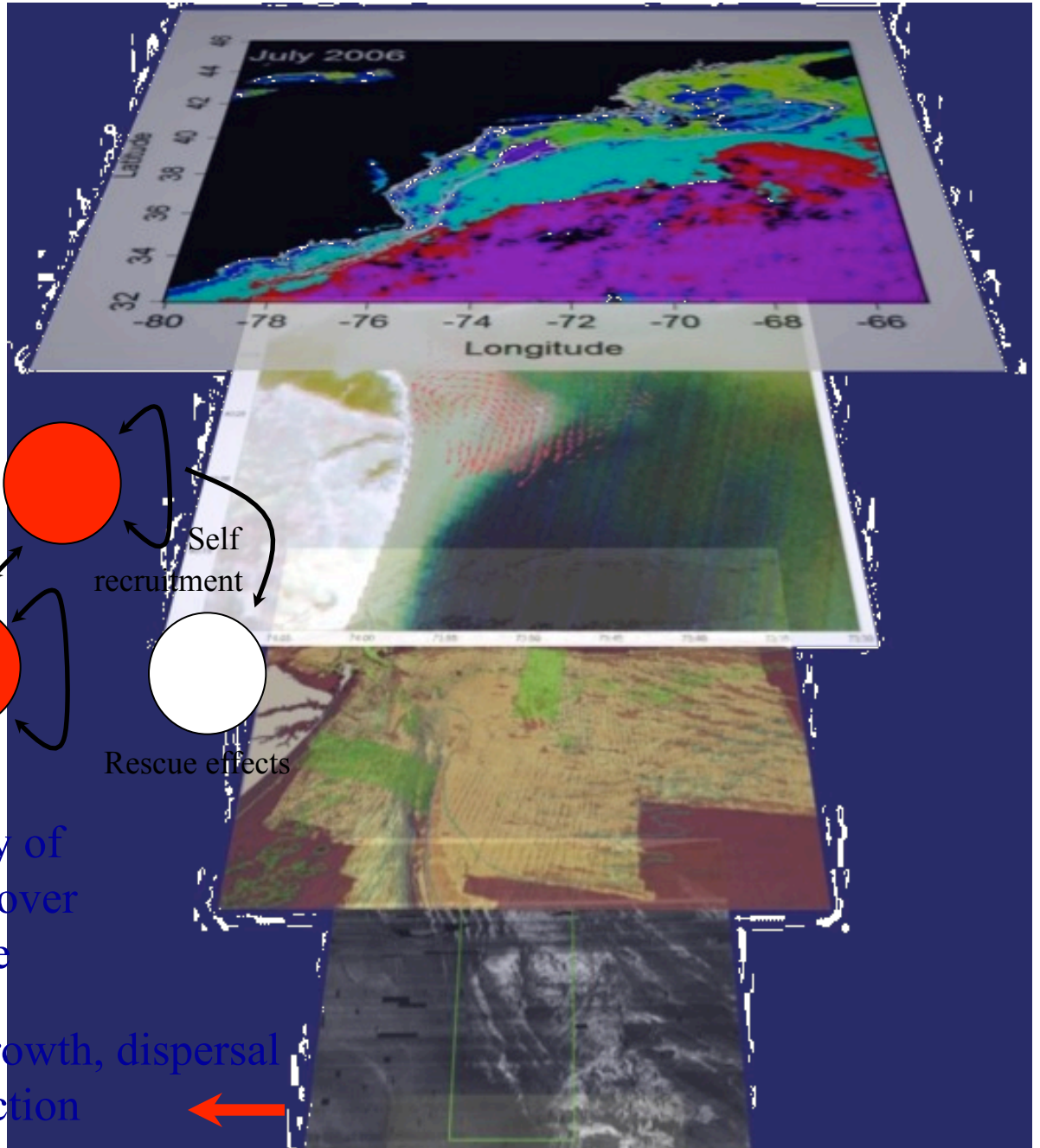
Multiple spawning habitats &
larval transport to multiple nurseries

Diversity of spawning & nursery habitats

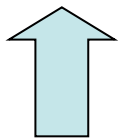
Variability Across Subpopulations



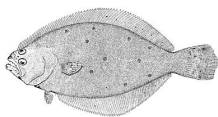
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Subpopulation



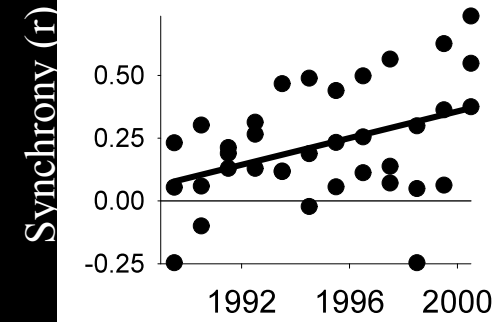
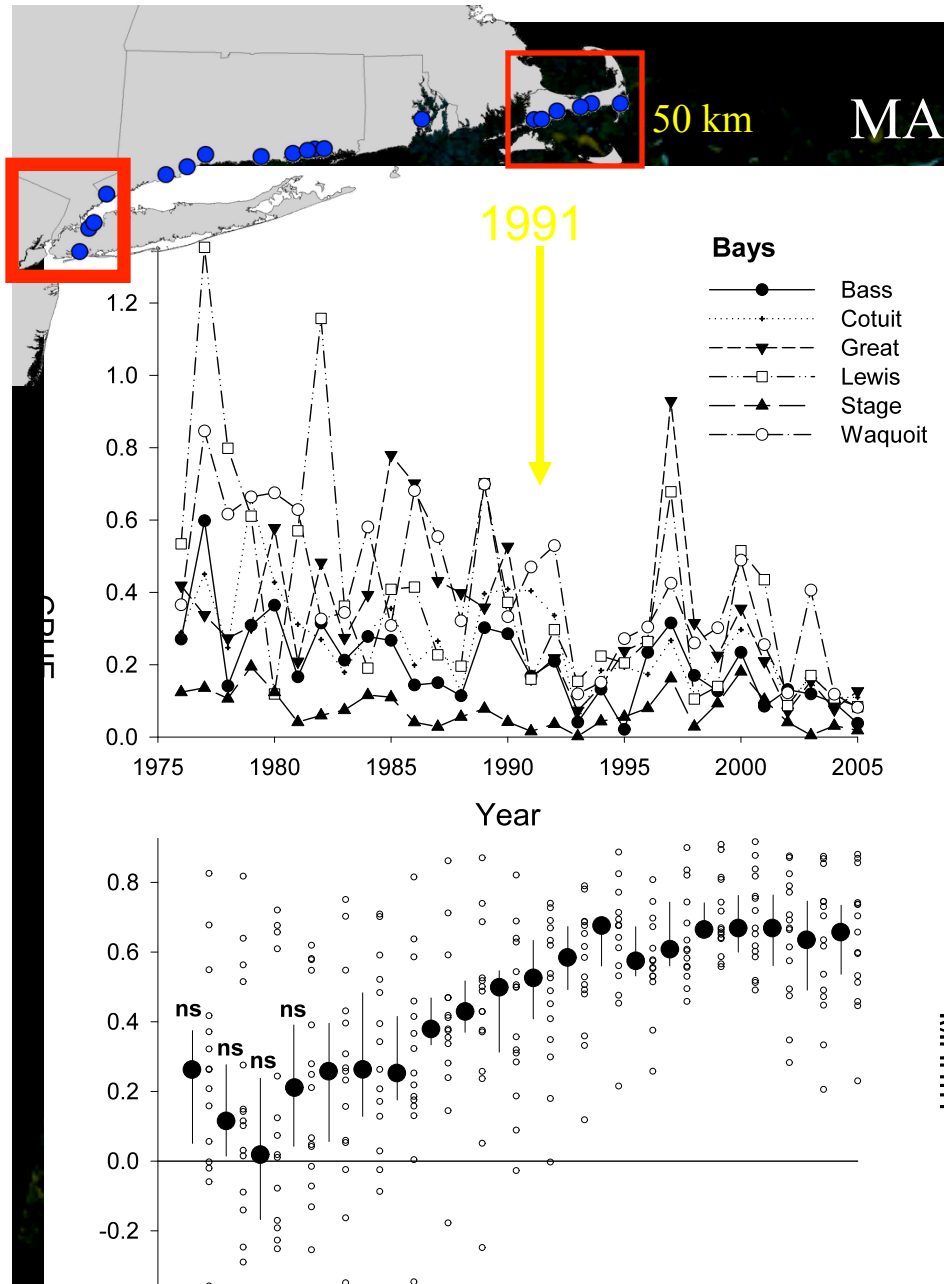
Individual



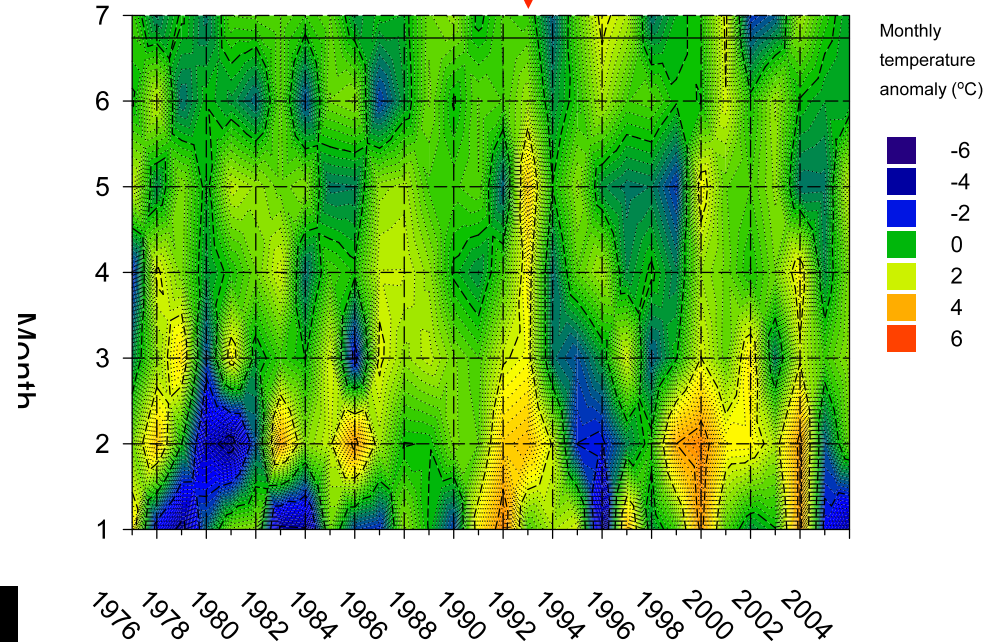
Diversity of
habitats over
life cycle

Birth, growth, dispersal
reproduction
death

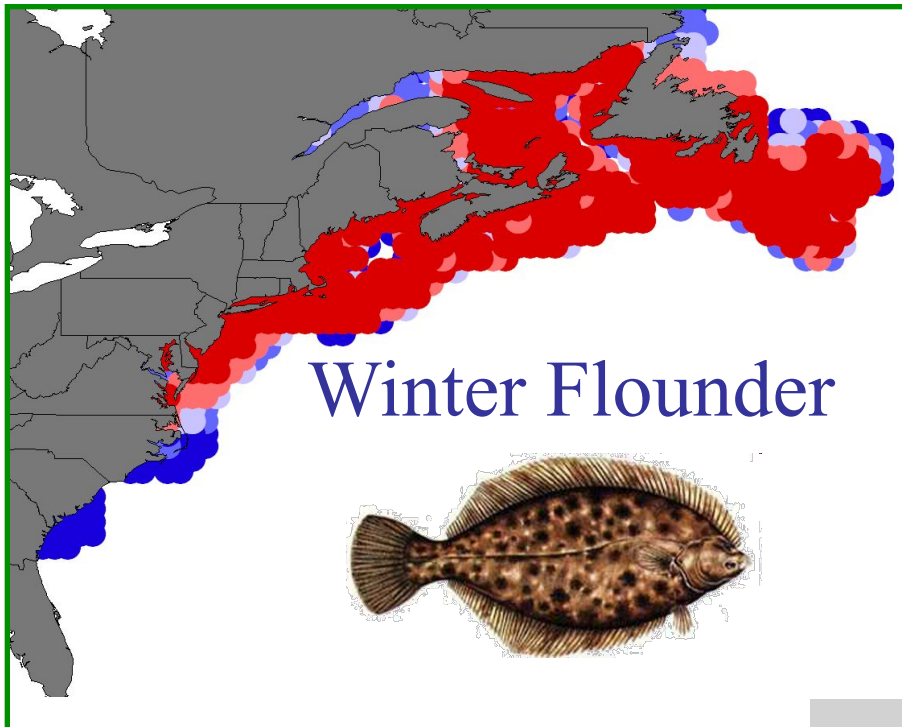
What happens with climate change MAB Winter flounder: cold temperate species



Synchrony scale < 50 km 1991 ~250 km



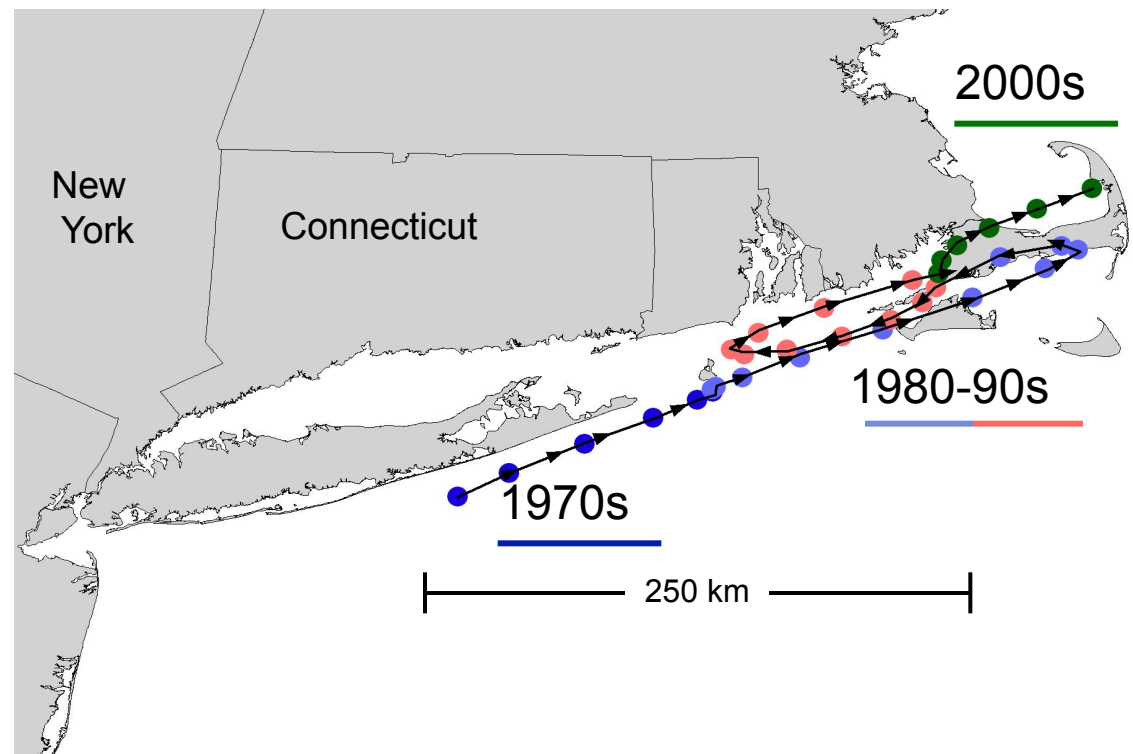
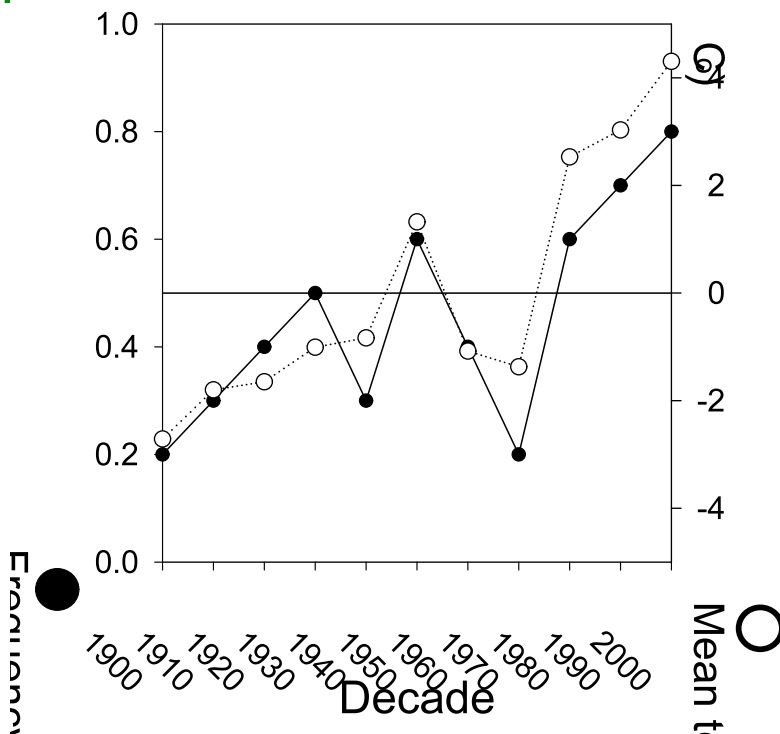
Control
Scale: Fine (e.g. prey) Coarse (e.g. temperature)



Climate change synchronizes sub-populations

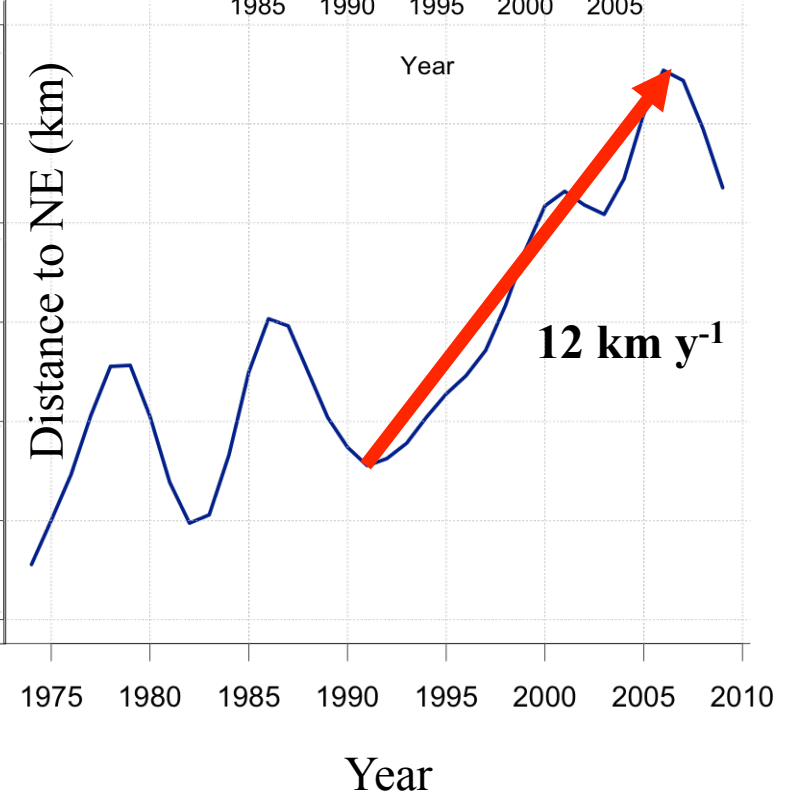
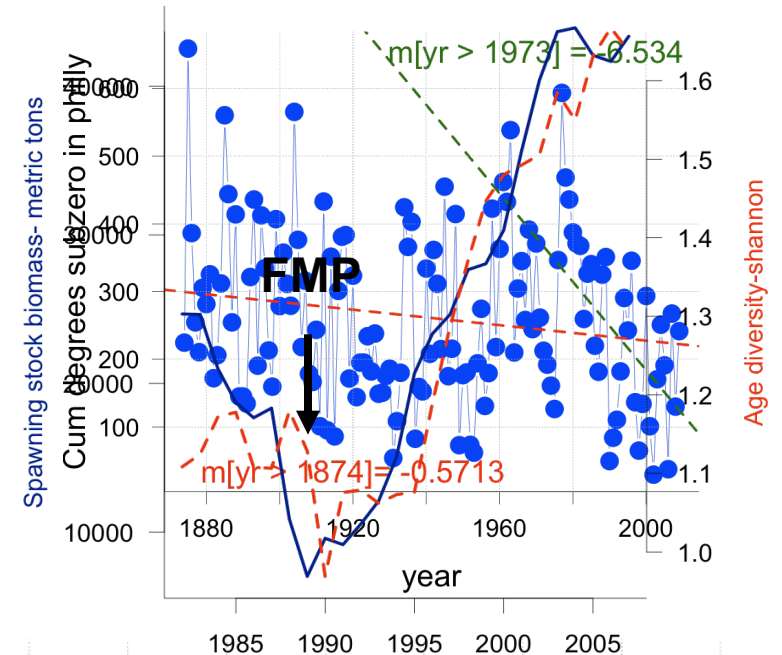
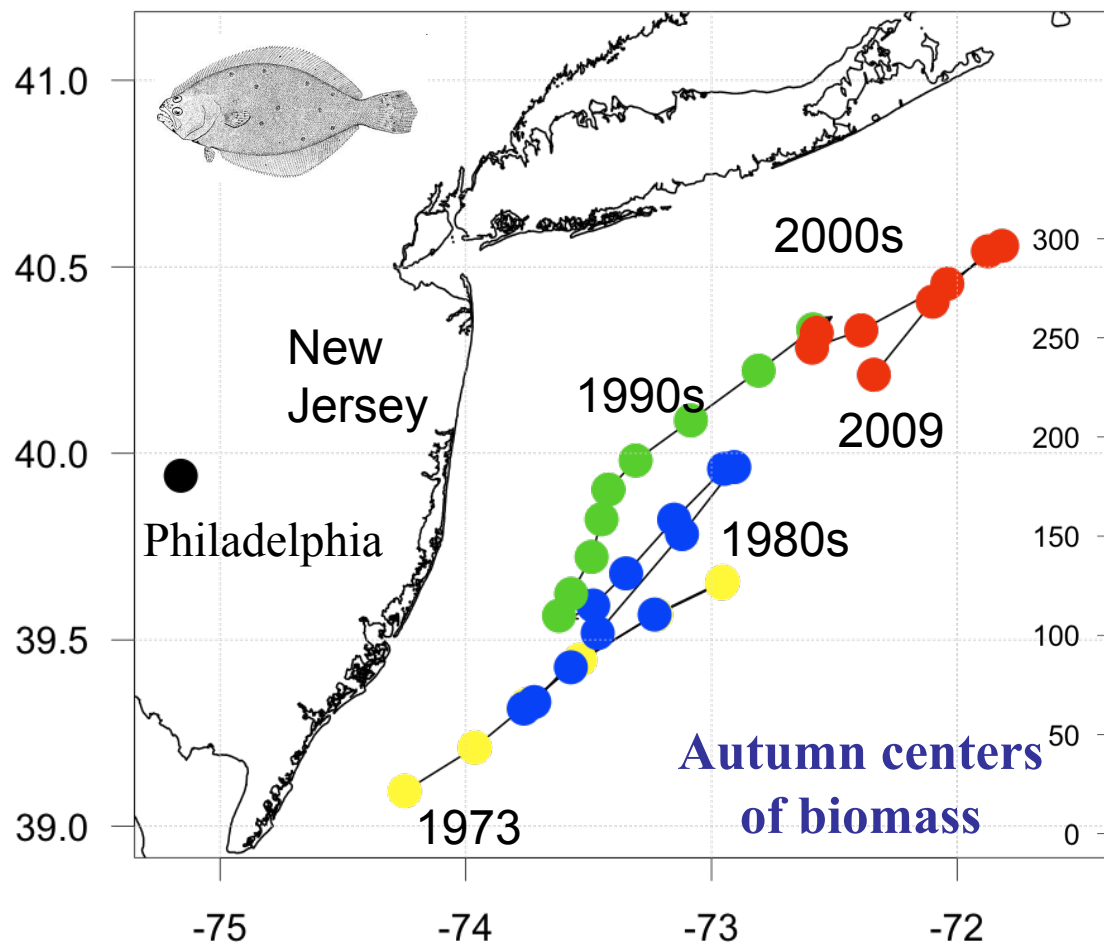
Populations lose resilience provided by habitat diversity

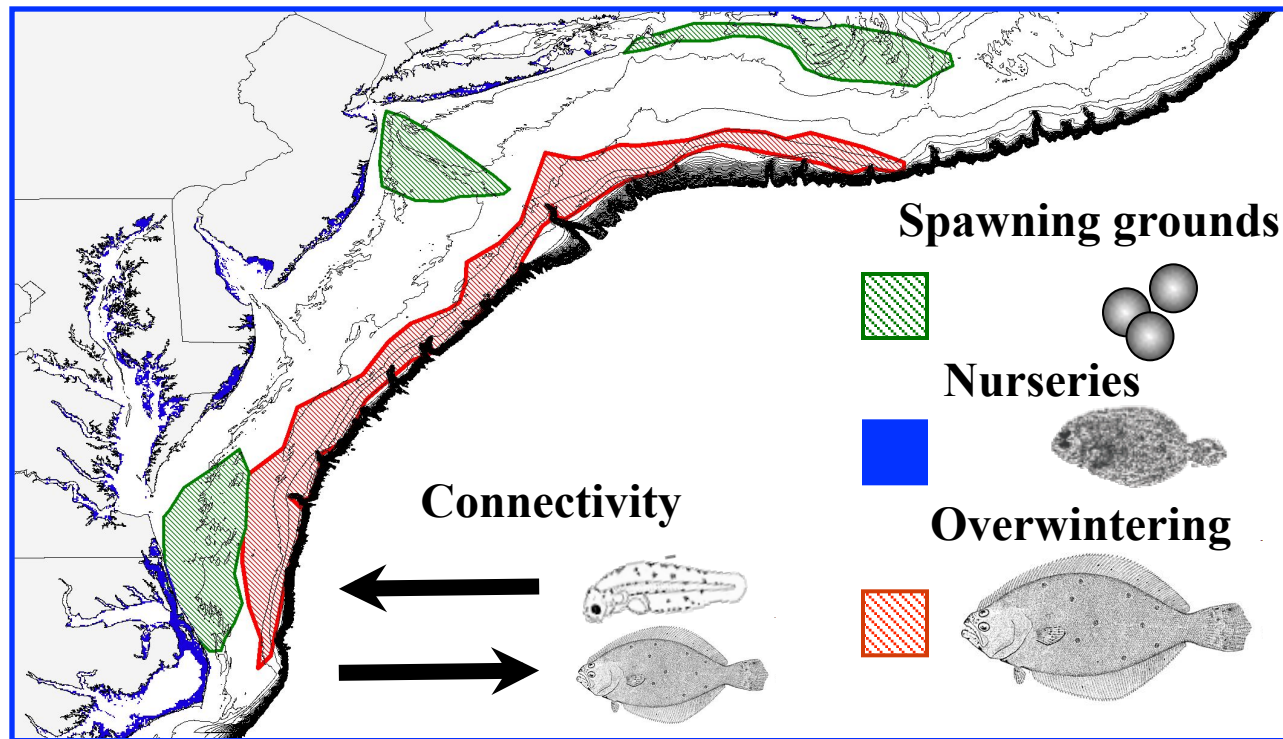
Center of Adult Distribution



Summer flounder: subtropical species

Life cycle coupling to NE?
Overwintering survival on
northern estuarine nurseries?





Effects of changing climate driven seascape variation on LH processes?

Are species (de) coupling life cycles in new (old) areas?

Ecosystem effects of species/life stages gained or lost
to food/interaction webs? (i.e. Metacommunity dynamics)

What parts & times of seascape need conservation to maintain (establish)
population stability & resilience?

Conserve life cycle & habitat diversity across species range

**Climate change is “habitat” change: Variables with fast-coarse “habitat” dynamics
“fragmentation” of the seascape in time**

Effects of heating, harvesting & habitat loss on populations
(Experimental microcosms ~ rotifers)

